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FEDERAL COMMUNICATIONS COMMISSION
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FCC Advisory Committee on Advanced Television Service
Implementation Subcommittee Working Party 2 on Transition Scenarios

Responses to Questions for Proponents

Following are the questions posed originally to proponents with a summary of the answers from each arranged following the original question. Supplementary questions were posed to each proponent based upon an original set of responses. The answers to the follow-up questions are included in the summaries where the follow-up questions have so far elicited responses. In the interest of keeping this document from becoming any longer than necessary, the follow-up questions are not repeated herein. They are available upon request from IS/WP-2.

General

Q1. Is extensibility built into your system? If so, are there extensions to your system that require particular consideration during the initial (full, but not extended) implementation? What are the considerations that must be addressed as part of the initial implementation?

NHK

1. Future improvement of dynamic resolution by adding motion vectors (all MUSE family members use only one currently).

    - Give up (reserve) data space — 60 kb/s for 140 vectors/field.

    - New receiver with additional 6 line memories and control circuits; original receivers can ignore new information.

2. Alternate media can use full MUSE quality if desired.

    - N-MUSE and MUSE use same algorithm, share same chip set.

    - Full-band MUSE digital input port can be provided in N-MUSE receiver to accept MUSE from some other service.

GI

1. Flexibility in compression/decompression supports various data rates from NTSC to HDTV and higher. Protocol and data structure are also flexible and can accommodate date from other services. Believe in concept of improved performance over time.

2. No answer yet to Specifics. Information on data/signalling, etc., soon to be released. No indication of how an initial DigiCipher receiver should be prepared to anticipate any particular extension(s).

   Present data structure is proprietary, not viewed as a "standard." Will be further defining protocol and willing to work with appropriate industry group to do so. Could incorporate aspects of SMPTE proposals.

Zenith/ATT

1. Possible extensions of performance of video and audio television services are discussed, variously implementable at the transmitter or the receiver, without impacting or making special provision in early receivers.

2. Data structure is particular to DSC-HDTV, not designed as a general communication system, but no particular ancillary data partitioning has been proposed. If the initial implementation of DSC-HDTV defines ancillary data as flexible packets with headers, new ancillary data services can be introduced later.

3. Headers/descriptors of the sort currently under consideration by SMPTE can be incorporated into DSC-HDTV global data packets with slight modification to the global data format. This would have to become part of the standardized system.

ATRC

1. Extensibility achieved by assigning a service code byte to each transport cell. New services, data (properly coded) can be added to digital stream at any time, for use only by receivers that recognize the particular code. Provides flexibility in mix of video, audio, and data for HDTV and in mix of services. There is no backward compatibility problem – early receivers ignore new services.

2. Have not identified any existing standard covering assignment of service types (ST). Those currently used arbitrarily selected, with additional types reserved for future use. Changing service type indicators is trivial.

3. Anticipate working with industry to finalize number and assignment of service types. If any standard is identified, will strongly consider its use.

MIT

1. Extensibility is provided by source-adaptive processing and the concept of headers.

2. Each image frame has a header containing information required or useful for interpretting the frame. Receiver can interpret header, properly decode, and ignore irrelevant information.

3. Current header protocols and data structures are proprietary, but flexible data structure permits adaptation to a reasonable industry standard.

4. Source adaptation sends source images in their native formats with any required format conversion done at the display. This is more efficient method in utilizing available bits than traditional approach of converting to a single format prior to transmission.

5. It is possible to use headers to select different encoding/decoding processes based on source format. CC-DC uses single encoding/decoding method with only the effective coding rate changed for the specific source.

Q2. How long following an Advisory Committee recommendation of your system will the detailed technical information necessary for the setting of standards and for the design and manufacture of both professional and consumer products be available?

NHK

1. The SS/WP-1 submission is a satisfactory introductory explanation. Standards setting information will be available after Advisory Committee recommendation for field test, before NPRM. Design/manufacturing information available during field test period. Part of coding is already in public domain in Japan.

GI

1. 0-3 months, for both standards setting and for design and manufacture.

Zenith/ATT

1. Both Zenith and AT&T have been responsive to this need in past standardization activities and will be for HDTV.

2. Development of standards and providing technical information for designers are separate issues. It is believed the proponent information for either or both will probably require 3 months to compile. Standards development may take an additional 3 months of effort by industry experts aided by the proponent.

ATRC

1. Much info is now available through ACATS documents, including SS/WP-1 submission, and through ISO-MPEG documentation.

2. Upon Advisory Committee recommendation (of ATRC system) detailed information will be available as quickly as possible given the scope of the task. Anticipate Advisory Committee and proponent(s) will agree on a timetable.

3. Anticipated time required to prepare final documentation on the order of 6 months.

MIT

1. A maximum of 4 months will be needed to supply technical information sufficient to begin the writing of both FCC Rules and industry technical standards. The information supplied during this period will be sufficient to permit start of IC and product design by manufacturers unrelated to system development program.

2. Personnel resources for development of necessary documentation will come from MIT's Advanced Television & Signal Processing Group and GI's VideoCipher division.

Q3. What provisions have you made for communicating information sufficient for design and manufacture to manufacturers of consumer and professional equipment? Do you have a program planned for providing direct support to help get such organizations up and running with your system?

NHK

1. NHK Engineering Services can provide all at any time under reasonable terms and conditions. Applies to any or all of proprietary info licensing, design diagrams, manufacturing know-how, and prototype evaluation.

2. Any proprietary information and manufacturing know-how necessary to commercial equipment, e.g. schematic diagrams, values of tap coefficients of digital filters, various kinds of parameters, will be subjects of doscussion of terms and conditions. Prototype evaluation service is included in technology transfer program but also available separately.

3. Information necessary to standards writing will be provided to any standardization organization without any restriction.

GI

1. Some internal discussions have taken place. GI has relevant experience in licensing and technical support. Such a function will be established for HDTV.

2. During remainder of 1992, GI will be exchanging information with a limited number of manufacturers. By the end of the year, GI will have developed a package for industry support.

Zenith/ATT

1. Nothing in place but intends to be responsive at the appropriate time. Both companies are experienced in this and business interests are best served by rapid deployment of all hardware, hence by rapid information dissemination.

2. Plan will include, but not be limited to, detailed technical information and diagrams, seminars as appropriate. The establishement of a program for direct support is premature until there is an unambiguous system selection.

ATRC

1. ATRC member companies are leading manufacturers of consumer and professional equipment and all experienced in launching new standards. Have a record of effectivley supporting technology transfer.

2. It is premature to discuss details of a technology transfer plan prior to selection of a system for field testing.

MIT

1. Both MIT and GI have experience in licensing and technical support and are communicating with manufacturers.

2. A specific plan for technology transfer has not yet been developed. MIT is working with GI to develop such a plan. The plan will involve technology transfer to both IC and product manufacturers.

Q4. What arrangements have you made with integrated circuit vendors for supplying chips for your system? What availability of ICs do you anticipate for other manufacturers of both consumer and professional equipment?

NHK

1. No specific arrangements. MUSE chips already commercially available, second generation due this spring. Specifically, no plans or arrangements to develop the N-MUSE-specific chips required.

2. Decoder should be built using and augmenting full-MUSE IC's. There is no economic advantage to a complete kit of dedicated N-MUSE IC's. Use of MUSE IC kit for part of the N-MUSE decoder saves time and development money, offers extensibility.

3. Use of Full MUSE chips for N-MUSE has little cost penalty since the MUSE chips and N-MUSE chips are of almost the same size and complexity. There might be slight memory savings for N-MUSE chips *vs.* MUSE but this is negligible. Some additional chips are necessary to interface MUSE IC's to N-MUSE system, but they are uncomplicated and would cost relatively little.

GI

1. GI has in-house capability and experience in VLSI for NTSC DigiCipher. Partitioning and estimation have been done for HDTV. Negotiating with vendors for HDTV IC development. Development time will be 18-24 months to availability to equipment manufacturers. (Presumed starting point from Q5: selection of system for field test will trigger hardware implementation.) (Also stated components and hardware may be available by the end of 1994.)

2. May make available 1st cut IC's, which will not necessarily conform to the final standards, for use in preliminary development of equipment.

3. On follow-up, expects to initiate serious IC development by mid-year 1992, and thus expects to have first IC's available by mid-year 1994.

Zenith/ATT

1. AT&T Microelectronics intends to be an industry supplier.

2. AT&T Microelectronics will provide production chip sets to support DSC-HDTV system introduction. In AT&T/ME business interests to make complete receiver chipsets available on a timely basis to other consumer electronics manufacturers and provide appropriate IC's to professional equipment manufacturers.

3. No response to follow-up question on how long following FCC decision chips will be made available to other manufacturers. Restatement of "timely" availability.

ATRC

1. MPEG-based compression is an advantage; some manufacturers are familiar with concept. HDTV MPEG expected sooner and lower cost than a proprietary scheme. (This HDTV MPEG content is about 50% of the IC kit — but not in existence with respect to either complexity or speed required.) IC development forecast at 18-24 months, except MPEG part may be quicker.

2. Various competing sources are expected; ATRC members will produce "appropriate" IC's for the open market. No specific arrangements for sourcing discussed.

3. IC design efforts at many companies will be triggered by an Advisory Committee recommendation and will be paced by a final FCC decision and timetable for implementation.

MIT

1. GI has in-house VLSI design capability. MIT/GI negotiating with IC vendors; expect chips to be widely available.

2. IC's are expected to be available within 18 months from the trigger point.

Q5. What is your expectation for the time of introduction of your system following the FCC decision? What point in the decision-making process (e.g. Advisory Committee Final Report, FCC Report & Order, completion of Field Test) will be the trigger for you to begin implementation in earnest? Do you have any suggestions for possible head starts in any areas to shorten the time to introduction?

NHK

1. Full service introduction (including alternate media) within 3 years of FCC decision.

2. Broadcast transmitter facility is critical path, including RF filter at the output.

3. Availability of MUSE receiver IC's and SMPTE 240M broadcast equipment can shorten time for certain equipment listed (but time not specified).

GI

1. System can be introduced within a year following Report & Order setting standard.

2. Selection of system for field test will trigger hardware development. Custom VLSI for encoder and decoder development will be the critical path.

3. Assuming FCC Report & Order by year-end 1993 and estimated IC availability by mid-year 1994, first receivers are estimated to be commercially available by year-end 1994.

4. Degree to which selected system is modified during FCC comment period preceding Report & Order constitutes risk for times estimated.

Zenith/ATT

1. Trigger for implementation will be an unambiguous selection of the DSC-HDTV system. This may be as early as an umambiguous selection for field testing.

2. Current timing estimate, based on system selection by FCC in mid-1993, indicates HDTV receivers and broadcast equipment beginning to be available by late 1995. Household penetration of 1 per cent is expected 2-3 years later.

ATRC

1. Implementation plans are underway. Display manufacturing facilities, requiring very long lead times and very large investments are already established.

2. On the Advisory Committee recommendation to the FCC, ATRC companies will begin product design cycles on remaining components (and presumably products).

3. PERT/Gantt chart times are aggressive but achievable. But choice of system may have a significant impact because of 2:1 raster and MPEG relationship.

4. Product design efforts will also be triggered by Advisory Committee recommendation and will be paced by final FCC decision and timetable for implementation.

MIT

1. Trigger will be the earlier of:
   - ATTC test results show CC-DC system is better than the others
   - System is chosen for field testing

2. Suggest all test results be made available as soon as possible.

3. Concept of system introduction is seen as commercial availability of transmitters and receivers. This is expected within 18 months from the FCC's decision.

Broadcast

Q1. What are the transmission power levels (ERP) required for the system for coverage equal to NTSC? Please specify for both low and high VHF and for UHF. Are there any power variations across the UHF band? Are any special transmitter or antenna characteristics required?

Power Levels of Proposed Systems

HDTV Proponent Predicted Transmitted Power Levels

	Average Power			Peak Power		
	Lo V	Hi V	UHF	Lo V	Hi V	UHF
Narrow MUSE	<-12.6 dB	<-12.6 dB	<-12.6 dB	-6 dB	-6 dB	-6 dB
DigiCipher	-18 dB	-18 dB	-13 dB	-11 dB	-11 dB	-6 dB
DSC-HDTV	-15 dB	-15 dB	-12 dB	-6 dB	-6 dB	-3 dB
AD-HDTV	-12 dB	-15 dB	-11 dB	-2 dB	-5 dB	-1 dB
CC-DigiCipher	-18 dB	-18 dB	-13 dB	-11 dB	-11 dB	-6 dB

All Reference: NTSC Peak Power Channels 6 = 20 dBk = 100 kW
13 = 25 dBk = 316 kW
36 = 37 dBk = 5000 kW

Based on Proponent Estimates as of 8/5/92

NHK

1. Noise figure of Narrow MUSE receiver will be 4-7 dB improved over NTSC receivers. This is all allocated to improving the noise performance of the receiver rather than extending the service area. Noise figure of current receivers is assumed to be 12 dB for VHF and 15 dB for UHF.

2. Relationship between peak and average power is important only for digital systems. In analog systems such as N-MUSE the average power is picture dependent. Average power of N-MUSE has been provided nonetheless for comparison's sake.

3. There are no power variations across the UHF band.

4. Required transmitter and antenna charateristics are described in a supplementary document (copy of a letter to chairman of SS/WP-2 Field Test Task Force).

Q2. What signal form is anticipated for use in the studio for program origination for your system? Are there different levels of quality and cost possible? If so, what are they and how are they accomplished? What are the trade-offs? What level of performance is achieved by each?

NHK

1. The SMPTE 240M signal format will be used for program origination for Narrow MUSE.

2. It is not a good idea to introduce an intermediate production format to reduce costs for broadcasters. This will lead to confusion and cost more in total to upgrade through the intermediate level to true HDTV equipment.

3. At the very beginning of the service, NTSC or widescreen 525-line components can be used with upconversion to 240M. An upconverter is already on the market.

GI

1. The input to the DigiCipher encoder is 1050/59.94/2:1. SMPTE 240M-type signals at 1125/59.94/2:1 can also be used with a transconverter to 1050. The quality loss of such a conversion is very small and usually not perceptible.

2. Use of 240M-type equipment is expected in the early stages because of the variety available.

3. "Pro compression" may be possible and is viewed as being intra-frame only, with data rates in the 100-200 Mb/s range. Pro compressions is assumed to be available eventually but possibly not in the early days of the HDTV broadcast service.

4. No compatibility problems between pro compression and DigiCipher compression are anticipated.

Zenith/ATT

1. For normal studio program sources: 787/59.94/1:1, GBR component signals. YUV component signals may be a good alternative for practical reasons. Lower quality can be obtained from upconverting widescreen 525/59.94/2:1 GBR component signals. Composite NTSC is also possible for even lower quality.

2. A two-dimensionally (2D) compressed version of the same signal is seen as an alternative requiring 200 Mb/s. This could be used in compressed form for scene cuts but would require decoding for other processing or image manipulation. Decoding to analog components is not necessary or desirable. Multiple digital-only encode/decode concatenations at 200 Mb/s are expected to be virtually transparent.

3. The 200 Mb/s signal may not support all studio operations without decoding but provides convenient single wire transport and switching. Using it for additional production processes is still under investigation.

ATRC

1. A variety of signal forms is anticipated. The AD-HDTV system design anticipates several levels of related MPEG compression that will support a variety of quality/cost levels.

2. Cameras will likely use 1050-line rasters with uncompressed data in the range of 620 — 1000 Mb/s. Studio recorders will likely be offered in different levels of cost and performance based on various levels of compression and/or subsampling, e.g. modest compression, yielding 216 Mb/s, could be recorded with D-1 technology at relatively modest cost.

3. MPEG compression at 216 Mb/s will be extremely high quality. At such a high data rate, concatenated compressions and decompressions should not be a problem. The approach should help reduce costs of recording, distribution, and switching equipment.

4. The scanning format and compression approach should be related to the terrestrial broadcasting standard, but the appropriate quality of compression and bit rates should be set by an industry organization such as SMPTE.

MIT

1. Signal formats expected for studio production initially are 720/59.94/1:1, 720/30/1:1, and 720/24/1:1, where 720 represents number of active lines. Later, 1080/30/1:1 is anticipated. Frame header will specify signal format used in transmission. At receiver, frame header will cause appropriate decoding and display of data consistent with the receiver display.

2. Any signal form is possible through source adaptivity.

3. The signal compression scheme can be used for production by increasing the allocated bit rate. At 180 Mb/s, a raster of 1280 x 720 pixels/frame at 60 frames/second would be indistinguishable from the original.

4. The 180 Mb/s compressed form would have to be decompressed prior to cutting, keying, or image manipulation.

5. The adequacy of the 180 Mb/s form has been examined using a computer simulation with a limited amount of data. This must be verified with a much more extensive set of data.

Q3. What signal form is anticipated for use in distribution to Network affiliates and/or to cable headends? Have you anticipated both satellite and terrestrial common carrier delivery? Have these been tested experimentally?

NHK

1. Two options:

   - Digitally compressed SMPTE 240M signal. Bit rate will be approximately 60 Mb/s.
   - Digital version of Narrow MUSE. Bit rate will be approximately 40 Mb/s after further compression of the N-MUSE signal.

2. Digital N-MUSE signal is further compressed using DPCM or similar technique, requiring less than 2:1 ratio. Compression is applied to digital version of N-MUSE extracted prior to modulator that generates analog signal for transmission.

3. Both satellite and terrestrial common carrier delivery anticipated. Schemes not tested for N-MUSE but similar to one used in service for fullband MUSE.

GI

1. During early years, distribution of the transmission signal is expected. Pass through operation will be principal method, with minimal local editing.

2. Over time, migration to a higher level DigiCipher feed ("distribution level") is expected from networks. While not lossless, this signal will have a data rate in the 30-40 Mb/s and be more transparent to editing.

3. DigiCipher compression at 30 Mb/s has been simulated with very pleasing results. Hardware tests are expected in the near future. Higher data rates will also be tried.

4. DigiCipher algorithm incorporates interframe coding and adaptively processes in field and frame modes.

5. Both satellite and fiber optic transmission can be used.

6. Satellites would use QPSK modulation. DigiCipher QPSK has been tested using the related multichannel NTSC system. Fiber optic and coaxial transmission have been tested by CableLabs during ATTC testing.

Zenith/ATT

1. Fully compressed form at a maximum data rate of 21.5 Mb/s is expected for distribution to "minimal television station." Terrestrial common carrier facilities capable of 21.5 Mb/s serial data will be suitable. The satellite version is being tested

with Scientific Atlanta. Same signal also appropriate for distribution to cable headends where pass-through is primary requirement.

2. For "transitional television station," where only limited post production is usually required, 100 Mb/s, 2D compressed signal is proposed. This could be sent over one satellite channel.

3. Both proposed rates, 21.5 & 100 Mb/s, would have to be supported by both satellite and common carrier distribution. Neither has been tested experimentally.

ATRC

1. MPEG compressed video at data rates well within satellite or terrestrial capability is anticipated.

2. MPEG compression carefully related to the terrestrial broadcast standard is the best choice. Issue of an appropriate quality/bit rate that takes account of subsequent compression/decompression should be addressed and standardized by an industry organization such as SMPTE.

3. During the transition period to HDTV, distribution will most frequently be a the compression level used for transmission. Local stations will perform minimal decompression and processing of the signal.

MIT

1. Both satellite and fiber optic transmission can be used.

2. Satellites would use QPSK modulation.

3. Initially, broadcast and cable networks will distribute signals at the transmission level of compression with emphasis on pass-through. There will be minimal local editing.

4. Later, distribution signals with bit rates between transmission and production levels will be used. The bit rate expected for such signals will be in the 30-50 Mb/s range. Inter-frame compression is anticipated.

Q4. What forms of further production are possible using the signal delivered to affiliates and headends?

a) cut into the signal
b) key into the signal
c) full image manipulation

NHK

1. With a digitally compressed SMPTE 240M signal at 60 Mb/s, all three processes are possible. The signal must be decoded to permit the three forms of processing.

2. With a digital N-MUSE signal at 40 Mb/s, only cuts are possible in the Narrow MUSE domain, as for commercial insertion.

GI

1. Cutting and keying may be possible without full decode/reencode, but full image manipulation will require full decode/reencode. This assumes use of the transmission level signal, the most demanding case.

2. Cuts would most effectively occur on frame boundaries. A cut-in should start with a PCM frame, which occurs on scene change. Cuts are most easily accomplished when both signals are at black.

Zenith/ATT

1. For the fully compressed, 21.5 Mb/s signal, because of the motion compensation used in the image compression, only cuts into the signal are possible. If done randomly, the artifacts introduced are similar to a channel change at a consumer receiver, with reacquisition in a few frames.

2. Clean cuts to and from black and at scene changes are believed possible without decoding.

3. For a two-dimensional distribution compression, cuts can be made at any time. Other processing appears to require decoding at least to digital components.

ATRC

1. Cuts may be achieved directly in compressed form if modest spatial compression (no motion compensation) is used.

2. High quality keys and full image manipulation require decompression of the video for processing.

3. Economic factors will be weighed against cost and quality of compression/ decompression to determine appropriate distribution formats for different applications and markets.

4. MPEG has unique advantage of spatially-coded frames on a periodic basis, allowing artifact-free cuts on Group of Pictures (GOP) boundaries, even in highly compressed transmission format. MPEG has further advantage that higher bit rates can be used with a different GOP structure to allow more accurate cuts in higher-quality signals.

5. Most production processes will require full decoding, although some might be achieved with partial decoding.

6. Signals with modest compression likely will be found in production and post-production equipment and contribution links, as described in the answer to B.2.

<u>MIT</u>

1. Cutting, keying, and image manipulation are all possible by first decoding the signal.

2. There is a possibility of partial decompression for further production. This would involve a fair amount of processing. It would be easier to decompress the signal fully.

Q5. If the signal delivered to affiliates/headends must be fully decoded for further production, in the forms listed in 4 above, how many times can this be done with acceptable quality in the resulting picture? Have you tested this experimentally?

NHK

1. If a digitally compressed SMPTE 240M signal at 60 Mb/s is used, the number of coding/decoding concatenations is two to maintain acceptable picture quality. This has not been tested.

2. It is assumed that, when digitally compressed N-MUSE is used for distribution, only the digital compression will be decoded, and N-MUSE will not be decoded. Signal processing is thus limited to cuts only. Concatenations of coding/decoding of the digital compression of N-MUSE are limited to two to maintain acceptable picture quality.

GI

1. Multiple pass encode/decode results in only modest loss in quality. Two pass concatenation has been tested. DigiCipher can support higher rate encoding for distribution to yield even less quality loss. Concatenation with a 45 Mb/s encoding scheme has also yielded only modest loss of quality.

Zenith/ATT

1. Cutting, keying, and full image manipulation are possible if the signal is decompressed, with resulting image quality being image dependent. Some non-real time simulations indicate this can be done several times without degradation, but results are source-signal dependent.

2. Decode/encode concatenation is most tolerant when decoded only to digital components.

3. Concatenation of the 21.5 Mb/s signal can leave image (hence source) content dependent artifacts. Artifacts are more likely as image complexity increases in all digital systems and depends on the algorithm used.

4. Concatenation of the 100 Mb/s encode/decode process is expected to be virtually transparent to 21.5 Mb/s transmission. Several concatenations should be possible with no noticeable artifacts following 21.5 Mb/s encoding/decoding.

5. Studies are being conducted with computer simulations.

ATRC

1. Uncompressed signals may be handled identically to CCIR 601 signals in a digital plant. Acceptable limits of compression/decompression in a post-processing environment are scene-dependent.

2. Most further processing at local stations will require full decoding, although some might be achieved with partial decoding.

MIT

1. Extensive multi-generation compression and decompression simulations have not been performed.

2. Based on limited simulations, multi-generation compression and decompression should be avoided for transmission signals but are possible for production signals.

Q6. Is it possible to carry the ATV signals and NTSC signals together on a single microwave channel, as for Studio-to-Transmitter Links (STLs) and similar circuits? If so, what is the required bandwidth?

NHK

1. Analog microwave links can be used with FM if 45 MHz bandwidth is available. Both NTSC and N-MUSE would need 17 MHZ, and a wide guardband is required to account for filter characteristics.

2. Digital microwave links can be used with QPSK and a bandwidth of 34 MHz. N-MUSE would require 40 Mb/s and NTSC 17 Mb/s.

3. To transmit both over a 25 MHz channel, digital compression with the same data rates of 40 Mb/s for N-MUSE and 17 Mb/s for NTSC can be used with 8ϕ PSK. QPSK could be used if a slightly higher compression ratio is applied.

GI

1. Required bandwidth depends upon type of modulation. With 32-QAM, one ATV and one NTSC signal can be carried in 9 MHz for the STL. FDM is believed more appropriate than TDM. 32-QAM is more spectrum than QPSK, although either could be used.

Zenith/ATT

1. Analog microwave links likely not to be able to pass analog NTSC with compressed DSC-HDTV because of intermodulation.

2. Compressed digital NTSC, frequency multiplexed with compressed DSC-HDTV, is possible on analog microwave links with a bandwidth of 10 to 12 MHz and a 3 MHz guardband between the two.

3. Digital microwave links would require 30 to 36 Mb/s to carry a multiplex of DSC-HDTV and compressed NTSC, depending upon the acceptable NTSC data rate (3.5 to 8.5 Mb/s) and assuming 20 per cent FEC overhead.

ATRC

1. Digital microwave links will allow a TDM mix of AD-HDTV and compressed digital NTSC. Existing digital microwave links can provide more than sufficient capacity for this. The AD-HDTV flexible data transport mechanism allows easy embedding of the digital NTSC data as a special service type. Required bandwidth is a function of the digital modulation technique; QPSK and QAM are commonly used.

2. Analog microwave links may handle AD-HDTV as an additional 6 MHz baseband signal. An FDM arrangement would need about 12 MHz including guardband. FDM is typically applied at some Intermediate Frequency.

MIT

1. Digital HDTV signals are compressed to 6 MHz and digital NTSC signals are compressed to 3 MHz. FDM multiplexing of the two would be most appropriate. The modulation would be on the microwave channel 32-QAM.

Q7. What signal form is anticipated for contribution circuits for production? Are different quality levels provided? Have you considered both satellite and terrestrial common carrier delivery? Assuming the production processes listed in 4 above, how many times through the signal form can an image go while retaining acceptable production quality in the resulting picture? Have you tested this experimentally?

NHK

1. Digitally compressed SMPTE 240M will be used for contribution. Two quality levels will require 60 Mb/s and 120 Mb/s, respectively. These bit rates can provide signal quality sufficient for post-production purposes.

2. For the 60 Mb/s signal, two concatenations of coding/decoding are possible. For the 120 Mb/s signal, more than five concatenations of coding/decoding are possible.

3. Lower bit rates might be possible for lower performance sources. Lower performance sources are not recommended, however, for the reasons given in the answer to B.2.

GI

1. Use of higher rate transmission is recommended for contribution circuits for production, as discussed in the answers to 3-5 above.

Zenith/ATT

1. Modest compression in two dimensions (no motion compensation) will provide very good quality for cutting, keying, and image manipulation.

2. Two-dimensional compression of DSC-HDTV in the order of 200 MHz is being actively pursued. Results are not yet ready for publication.

3. See the answers to B.2-B.5 above for more information.

ATRC

1. Contribution signals are expected to be MPEG compressed video at data rates appropriate for satellite and terrestrial circuits. Contribution and distribution will most likely differ in the amount and type of compression/decompression, e.g. motion-compensated *vs.* spatial. (See also answer to Question 3.) Contribution standards should be carefully related to the terrestrial simulcast standard just as in the case of distribution standards.

2. There are many possibilities that have cost/performance tradeoffs. Decisions on these issues should be made by the industry.

MIT

1. Contribution circuits may use same signal format as broadcast link. Higher data rate is useful if signal is to be further processed. Other signal formats also acceptable. Production quality after multiple encode/decode passes not tested but expected to depend strongly on data rate used. See also answer to B.3.

Cable

Q1. What provisions are made for conditional access without decoding the signal? Is partial decoding required? How complex is the equipment required to accomplish these functions?

NHK

1. The conditional access planned is the same as developed for fullband MUSE. This combines line rotation and line permutation. It is described in the Narrow MUSE System Description document.

2. There is no need to decode the video signal to recover the key information, but the digital data during the vertical blanking interval must be decoded.

3. Equipment complexity for N-MUSE is the same as for fullband MUSE, where an encoder takes one rack with three shelves and a decoder currently uses six chips in addition the N-MUSE encoder and decoder hardware. This will be reduced in commercial equipment because current equipment is prototype hardware.

GI

1. Protocol designed to support conditional access without decoding. Cable headend could insert or delete authorization information without decoding signal.

2. Equipment needed is not complex and can be done either at a source or downstream. Scrambling can be done by bit-by-bit Exclusive OR'ing with a pseudo-random data stream. Channel synchronization and data stripping can be done while maintaining the picture in a scrambled mode.

Zenith/ATT

1. Conditional access, i.e. insertion and capture of address/enable instructions, can be accomplished without decompressing the fully compressed 21.5 Mb/s signal. Channel synchronization, clocks, and general timing information are neither video encoded nor encrypted when the program is encrypted.

2. Encryption of the program can take many forms, one of which is the stream-cipher process contemplated. This process adds a known (but secret) pseudo-random number series to the message (program) data stream. Decrypting is the complementary process.

3. With key passing and addressing accommodated with the ancillary data channel, either encrypting or decrypting can be carried out any any point, origination or downstream, with simple equipment and without decompressing the 21.5 Mb/s (or any other) signal.

ATRC

1. Conditional access data can be decoded without decoding video and audio. It can be treated as a separate service type or included with the video/audio data.

2. Receivers can be built to decode only conditional access data and then to decode video and audio only after receiving authorization.

3. Digital encryption can be performed at any downstream point. AD-HDTV offers several layers at which encryption may be applied.

MIT

1. Decoding not required for conditional access data (or for Auxiliary data or Audio data). Such operations are very simple, given the digital time-division-multiplexed nature of the signal.

2. The scrambling operation is straightforward. It can be done at the source or downstream. Channel synchronization and data stripping can be accomplished with a scrambled picture.